A NOTE ON THE ELECTRIFICATION OF POWDERED INSULATORS

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Since the presentation of my paper to the Physical Society, on 28 April 1939, on "A new method of creating electrification" a contribution on the same subject has been made by Dr. Robert Schnurmann (1940) in which experiments made by Coehn and Lotz are described concerning the electrification of powdered dielectrics. I have verified most of the results mentioned. I find, as stated, that it is not necessary to allow a powder of some insulator to fall on a perforated zinc plate, but some electrification of the powder can be obtained by allowing it to fall on a metal plate connected to an electroscope, provided the silica powder does not remain on the plate but falls off it instantly. Silica powder was used in the above-mentioned work of Coehn, but I have found that powdered sulphur gives good results. The sulphur must be prepared from crushed and sifted roll sulphur. Flowers of sulphur does not flow easily enough out of a containing vessel.

My experiments were made as follows:—A bottom portion of a tin canister, three inches in diameter and three inches deep, was placed on the plate of an electroscope. On pouring into this tin receptacle powdered silica in a continuous stream from a glass or metal vessel held about a foot above the receptacle, the gold leaves of the electroscope diverge and show a negative charge given to it. The results are, however, very variable. In the case of some glass bottles or vessels the electrification of the silica powder poured from them is very strong, and for other glass vessels little or no electrification is shown. Sulphur powder, even in small quantities, poured into the receptacle gives strong negative electrification far more than silica. The most uniform results I find are obtained when the powder of silica or sulphur is poured from a glass or metal container into a small tin funnel held above the receptacle on the electroscope, so that a steady slender stream of particles falls into the receptacle.

If the receptacle is lined with paraffined paper made by soaking white paper in melted paraffin wax, the electrification obtained is nearly as great as when the bare metal receptacle is used. This shows that the charge is not entirely due to the particles of insulator impinging on metal, but that the charge on the insulating powder must partly be obtained when it leaves the spout of the tin or glass funnel. But the electrification does depend in some degree on the velocity with which

the particles strike the receptacle. Only when good insulators such as silica or sulphur are employed as powders is any electric charge obtained. I have tried carborundum, bauxite, emery and rochelle salt in powder without results, but all these substances in powder form have some degree of conductivity for electricity. The most uniform results are obtained when powdered silica or sulphur is poured from a height of several inches on a perforated zinc plate held over, but not touching, the receptacle on the electroscope. We then find that a strong negative charge is given to the electroscope by the powder which has passed through the holes in the perforated zinc plate.

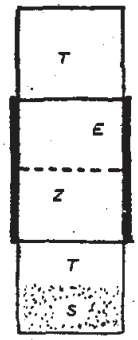

Figure 1.
TT, tin canisters; *E*, ebonite tube;
Z, perforated zinc plate; *S*, silica powder.

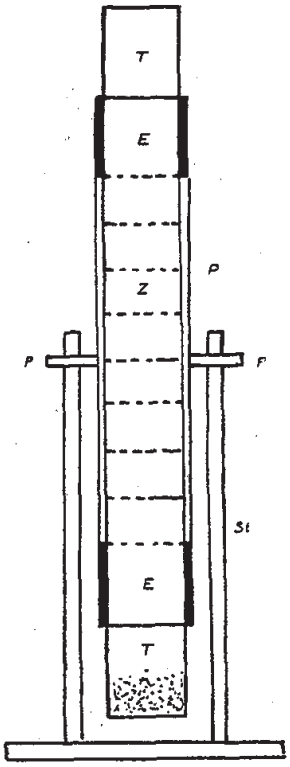

Figure 2.
TT, tin canisters; *EE*, ebonite tubes;
Z, perforated zinc plates ; *pp*, pivots;
PP, card tube; *St*, stand.

Based on this fact I have made a little apparatus by which an unlimited amount of negative electricity can be obtained by the use of a single small quantity of silica powder by causing the powder to fall again and again through a perforated zinc plate. The apparatus is made as follows:—An ebonite tube about four inches in diameter and six inches long has a partition of perforated zinc placed across it at its centre (see figure 1). The ends of this tube are closed by tightly fitting tin canisters, and in one of these a charge of about $\frac{1}{4}$ or $\frac{1}{2}$ a pound of well-dried silica is placed. If the apparatus is held in a vertical position the silica all falls into the bottom canister. If the tube is then turned over like an hour-glass or egg-boiler, the silica comes into the top and falls down again through the perforated zinc

partition into the lower cylinder. It thus gives to that cylinder a negative charge of electricity. This charge can be put into an electric condenser formed of two metal plates separated by a thin sheet of ebonite. The apparatus can then be reversed in position many times, and at each reversal the silica conveys a negative charge to the lower cylinder and to the condenser. If then the condenser plates are separated by insulating handles, their electric capacity is reduced and potential raised, and if the two condenser plates are brought close together a small electric spark can be seen.

I have also found that by allowing the silica to fall through several perforated zinc plates in succession the charge is increased. Hence another apparatus has been made, as follows:—A card tube of square section, about 42 inches long and 4inches inside, has about ten partitions of perforated zinc placed across it at intervals of four inches (see figure 2). The ends of the card tube are closed by short ebonite tubes, and these again by tin canisters to form receptacles for the silica. The card tube is enclosed in a wood tube, and at the centre, pivots are placed by which it is supported in a suitable stand to enable it to be turned upside down repeatedly. At each such reversal the charge of silica powder falls through the ten perforated zinc partitions and gives a charge of negative electricity to the lower cylinder. By repeated reversals of position of the tube the electric charges produced can be put into an electric condenser and so accumulated as above described.

The point to be particularly noticed is that success in these experiments can only be obtained if the silica powder is very well dried by heating it for some time to above 100° C. just before using it.

One conclusion which may be drawn from the foregoing experiments is that when particles of a good insulator, that is, one with few or no free electrons in it, strike with some velocity a metal surface or one in which there are many free electrons, electrons tend to pass from the medium in which the electron density is large to the one in which it is small. Hence the particles of silica or sulphur carry with them when they bounce off or pass through the metal sheet a negative charge. If these particles fall into the interior of an insulated canister connected to an electroscope they give a negative charge to the electroscope. I find also that if these negatively charged insulator particles fall into a space filled with water-cloud such as is created by slightly condensed steam (e.g. that given from the spout of a kettle), the particles act as condensation nuclei and form larger water particles or rain, thus dissipating the cloud sooner than it would disappear if left to itself.

This assumption explains quite clearly all the facts noticed in the above-described experiments.

REFERENCES

FLEMING, Sir J. A., 1939. *Proc. Phys. Soc.* **51**, 402.
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